Long term effects of soil tillage systems and crop sequence on irrigated wheat grain yield in temperate-cold climate

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Seed and Plant Improvement Institute

Wheat area in Iran: 6.06 million hectare (almost more than half of area for all the crops (51.2%) with the total production of more than 10.5 million tones (Anonymous1, 2014).

Consequences and causes related to the conventional continuous intensive production of irrigated wheat in Iran

- Unsustainability, fragility and grain yield variability of crop production environments
- Continuous increasing gap between achievable and real wheat grain yield
- Dominant one crop view vs. cropping system view considering neither of the system approach policies for the irrigated wheat target environments based on its capabilities and limitations
- Soil and water natural resources degradation
- Subsistence view crop production instead of agro-ecological based considerations or compromises
- Reducing efficiencies of the agricultural inputs due to their increasing consumption and dependency by the cost of losing resources, inputs and the whole system of production in the near future
- Environmental health risks like contamination of the natural resources and crops

Conservation Agriculture in irrigated land

Conservation Agriculture in irrigated land is a holistic cropping or farming system to change farmers' behavior and culture through considering crop rotation (sequence), manage crop residue(s) and lessen soil disturbance toward soil health and economic production with the ultimate goal of creating a sustainable and feasible way of crop production

“Diversified Crop Sequence”

The best and the most important principle of CA in irrigated environments

Diversified Crop Sequence is the key and the most influential factor in irrigated cropping systems comparing soil disturbance and residue management to minimize risk of the production system and also to improve efficiency of the cropping system

Crop residue management

- ✓ Crop residue burning
- ✓ Keeping crop residue on the soil surface (Mulch)
- ✓ Complete or partial removal of the crop residues from the soil surface
- ✓ Crop residue complete or **Partial incorporation**
- ✓ **Diversified crop residue from diversified crop sequence**

Challenges in sustainable production of irrigated wheat in Iran

- Challenges in Sustainable production of irrigated wheat quantity and quality in Iran despite diversified genotypes and HYP varieties:
- Based on the data (2004-14) with mean grain yield of 3827 to 3138 Kg ha^{-1}which means 18% reduction.

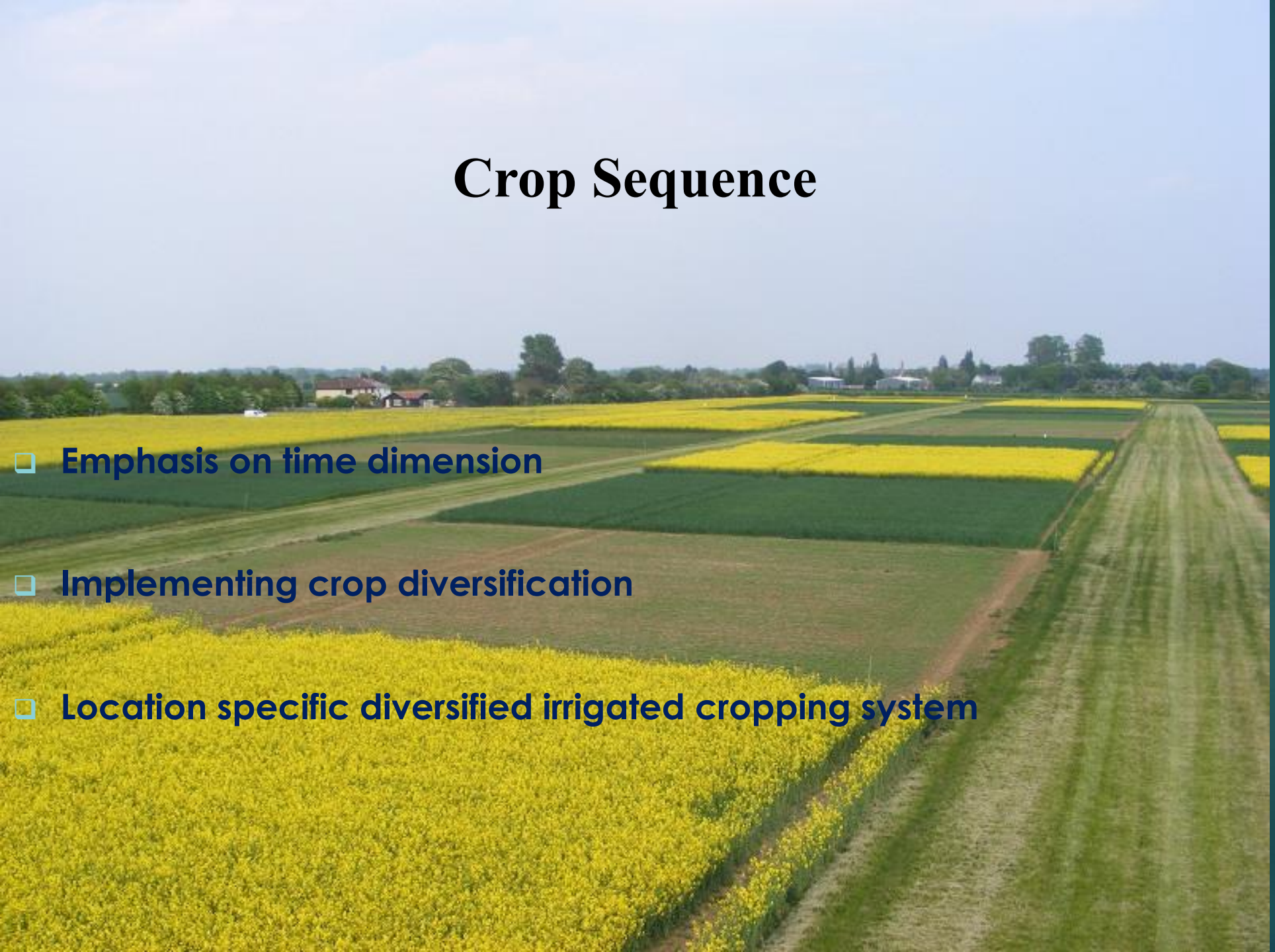
Soil erosion in Iran

- Soil erosion caused by conventional tillage in irrigated lands in very high (17 tones per hectares of land (Tabatabaiefar, 2008) with the equivalent weight of 2 billion tones of fertile soil and approximate damage of 56 billion US$ (Gorgi, 2014).

Cereals Straw burning

Irrational soil resource utilization

Crop Sequence

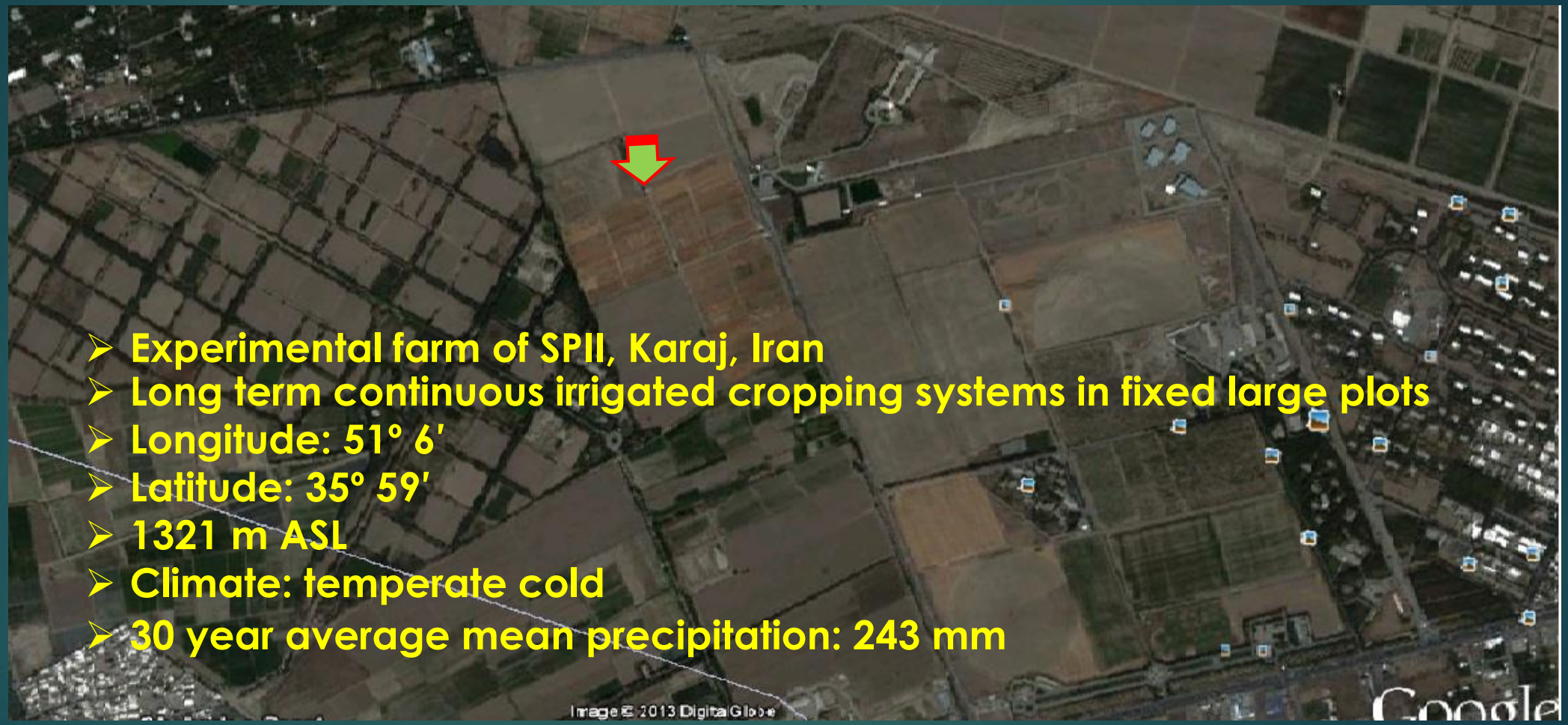


- Emphasis on time dimension
- Implementing crop diversification
- Location specific diversified irrigated cropping system

Objectives

- ✓ Comparison of the conventional and conservation based cropping systems
- ✓ Studying applicable cropping systems from agronomic, economic and environmental aspects
- ✓ The best efficient crop sequence(s) in long term for irrigated lands of the target environment
- ✓ Crop residue managed approaches compatible with conventional and CA based cropping systems

Research experiment location specs.



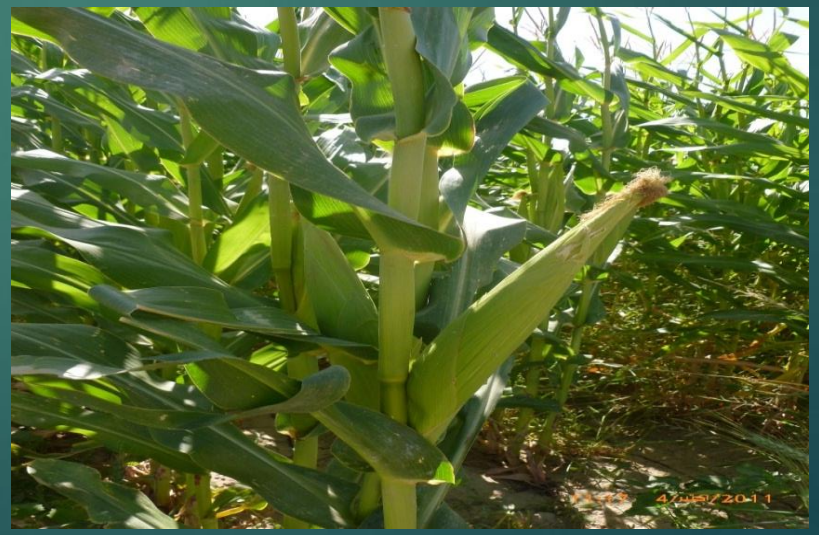
- Experimental farm of SPII, Karaj, Iran
- Long term continuous irrigated cropping systems in fixed large plots
- Longitude: 51° 6′
- Latitude: 35° 59′
- 1321 m ASL
- Climate: temperate cold
- 30 year average mean precipitation: 243 mm

Crop types cultivated

Irrigated wheat CV. Parsi

Berseem clover Karaj local population

Canola CV. Zarfam



Maize KSC-704

Crop Sequences Planting Pattern

- 1st year-1st cropping
- 1st year-2nd cropping
- 2nd year-3rd cropping
- 2nd year-4th cropping

Amount of seed for planting (Kg ha^{-1})	Crop
200	Wheat
12	Canola
35	Silage maize
25	Berseem clover

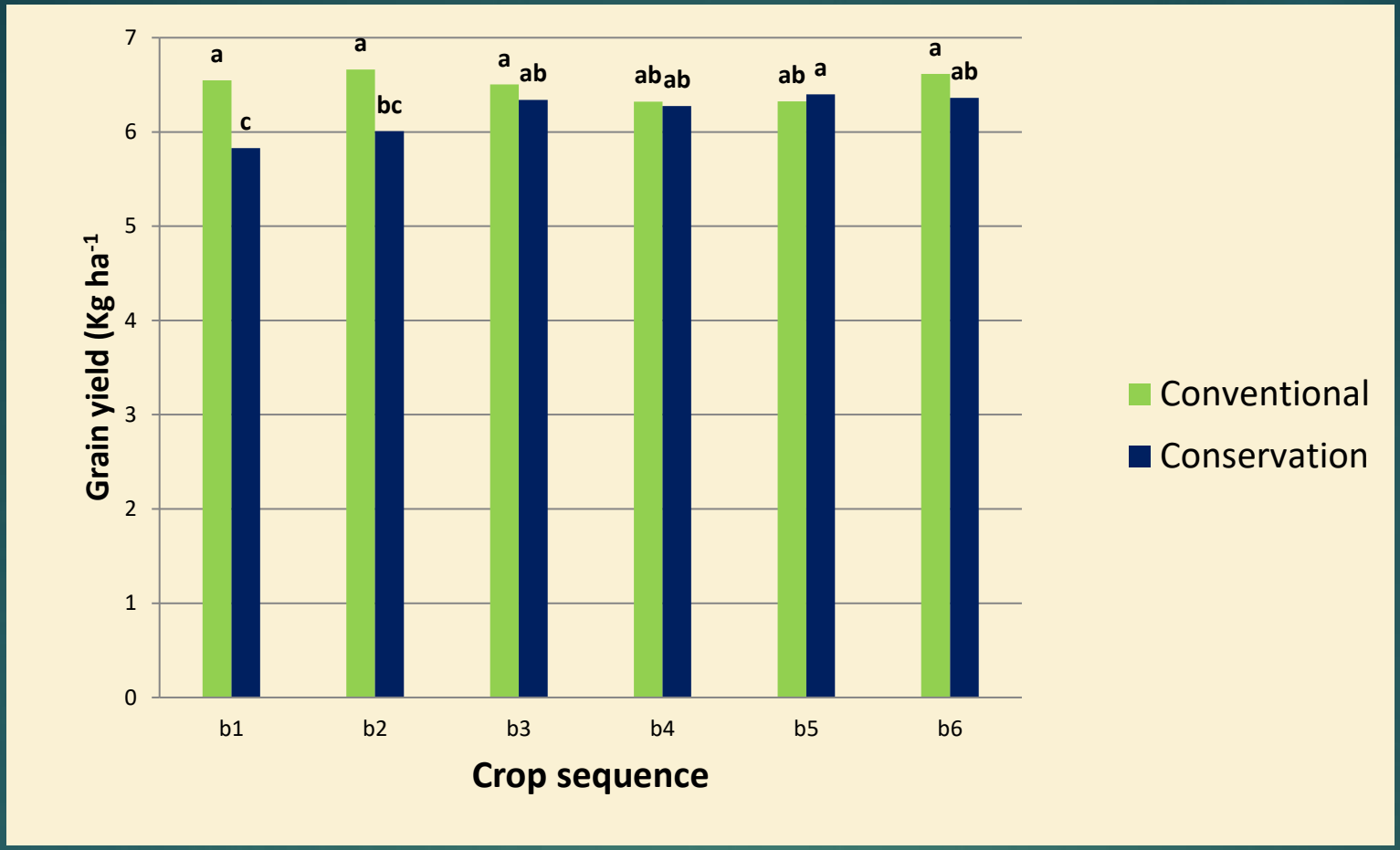
TARASHKADEH

TARASHKADEH
TARASHKADEH

Speed Box
5000
Baldan

1st year-1st cropping

Harvest index	Biologiclayield (kg ha^{-1})	Grain yield (kg ha^{-1})	TGW (gr)	Grains per spike	Spikes $^{m-1}$	Spike length (cm)	Plant height (cm)	DF	S.O.V.
14.96**	93082.70^{ns}	593651.69^{ns}	4.61^{ns}	4.73^{ns}	349.48^{ns}	0.99^{ns}	5.66^{ns}	2	Rep
8.09^{ns}	1130096.56**	778138.63**	3.38^{ns}	9.87^{ns}	1927.50**	1.24^{ns}	145.68**	1	Managed approach (A)
1.27	43208.30	12877.52	1.31	0.07	113.85	1.05	0.47	2	E1
0.38^{ns}	287994.14^{ns}	64609.51^{ns}	0.69^{ns}	0.44^{ns}	12.07^{ns}	0.13^{ns}	4.57^{ns}	5	Crop sequence (B)
14.14**	383593.94*	159030.47*	1.14^{ns}	0.52^{ns}	13.78^{ns}	0.13^{ns}	0.56^{ns}	5	AB
1.92	137038.17	39989.66	3.69	2.39	210.84	0.90	11.67	20	E2
3.62	2.23	3.14	4.51	4.05	3.92	9.19	3.41		(CV%)



1st year 1st cropping wheat grain yield (Kg ha-1)

b1: Wheat/Maize-Wheat/Maize
b2: Wheat-Berseem clover/Maize
b3: Wheat/Berseem clover-Canola/Maize
b4: Wheat/Maize-Canola/Maize
b5: Wheat/Maize-Canola/Berseem clover
b6: Wheat/Berseem clover -Wheat/Maize

1st year 1st cropping wheat grain yield mean comparison (DMRT 5%)

Harvest index	Biologicla yield (kg ha^{-1})	Grain yield (kg ha^{-1})	TGW (gr)	Grains per spike	Spikes $^{m-1}$	Spike length (cm)	Plant height (cm)	
								Managed approach
39/ 56 a	16416/ 34 b	6496/ 10 a	42/ 69 a	39/ 35 a	385 / 19 a	10 53 a	96/ 11 a	Conventional
36 / 96 b	16770/ 69 a	6202/ 06 b	43 / 61 a	38 / 51 a	368 / 82 b	10 16 a	92/ 08 b	Conservation

1st year wheat yield

Based on the results of anova and means comparison, tillage systems had a significant effect on grain yield, wheat height, fertile spikes per square meter, biological yield and harvest index ($p<0.01$), but the effect of crop rotations (crop sequences) was not significant on all the studied traits.

2nd year 3rd cropping

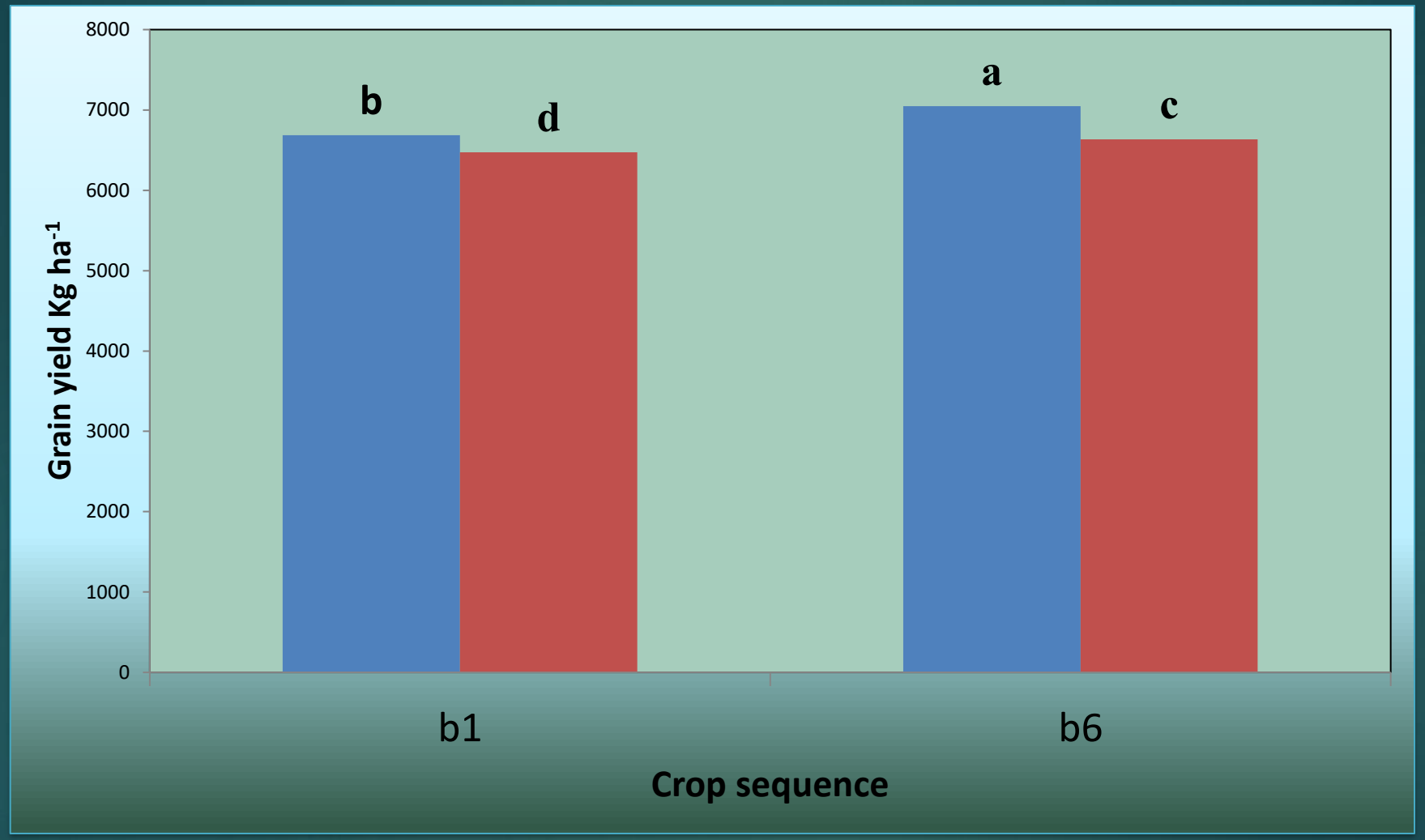
Wheat I 2nd year 3rd cropping

Harvest index	Biological yield (Kg ha^{-1})	Grain yield (Kg ha^{-1})	TGW (g)	Seeds per spike	Spikes per m^2	Spike length (Cm)	Plant height (Cm)	
								Managed approach
36 . 69$_a$	19567 . 1$_a$	7176 . 30$_a$	43. 99$_a$	39. 83$_a$	404 .68$_a$	11.82$_a$	94.66$_a$	Conventional
36 . 96$_a$	18568 . 8$_b$	6860 . 90$_b$	44 . 97$_b$	39. 59$_a$	384. 31$_b$	11. 75$_a$	90. 44$_b$	Conservation
								Crop sequence
36 . 78$_a$	18913. 8$_a$	6953 . 91$_b$	44 . 05$_a$	39. 61$_a$	390. 41$_b$	11. 75$_a$	91. 73$_b$	B1
36 . 88$_a$	19222. 0$_a$	7083 . 29$_a$	44 . 90$_a$	39. 81$_a$	398 . 58$_a$	11. 81$_a$	93. 37$_a$	B6

b1 = 1st crop sequence - Wheat/maize-wheat/maize

b6 = 6th crop sequence - wheat/berseem clover-wheat/berseem clover

(Gursoy et al., 2010)
(Zabolestani et al 2009)
(Singer et al, 2004)



Conventional

Conservation

2nd year 3rd cropping wheat grain yield in managed approaches and crop sequences

Despite small negative effect of no-till on yield and yield components of all the crops in sequence for the 1st and 2nd two years of study, the yield reduction in no-till was not so much high not to compensate its expenses.

The net profits for the most of the crop sequences under conservation were more than conventional managed approach, while the income/expenses ratio or its economic efficiency was also higher in conservation comparing to the conventional managed approach.

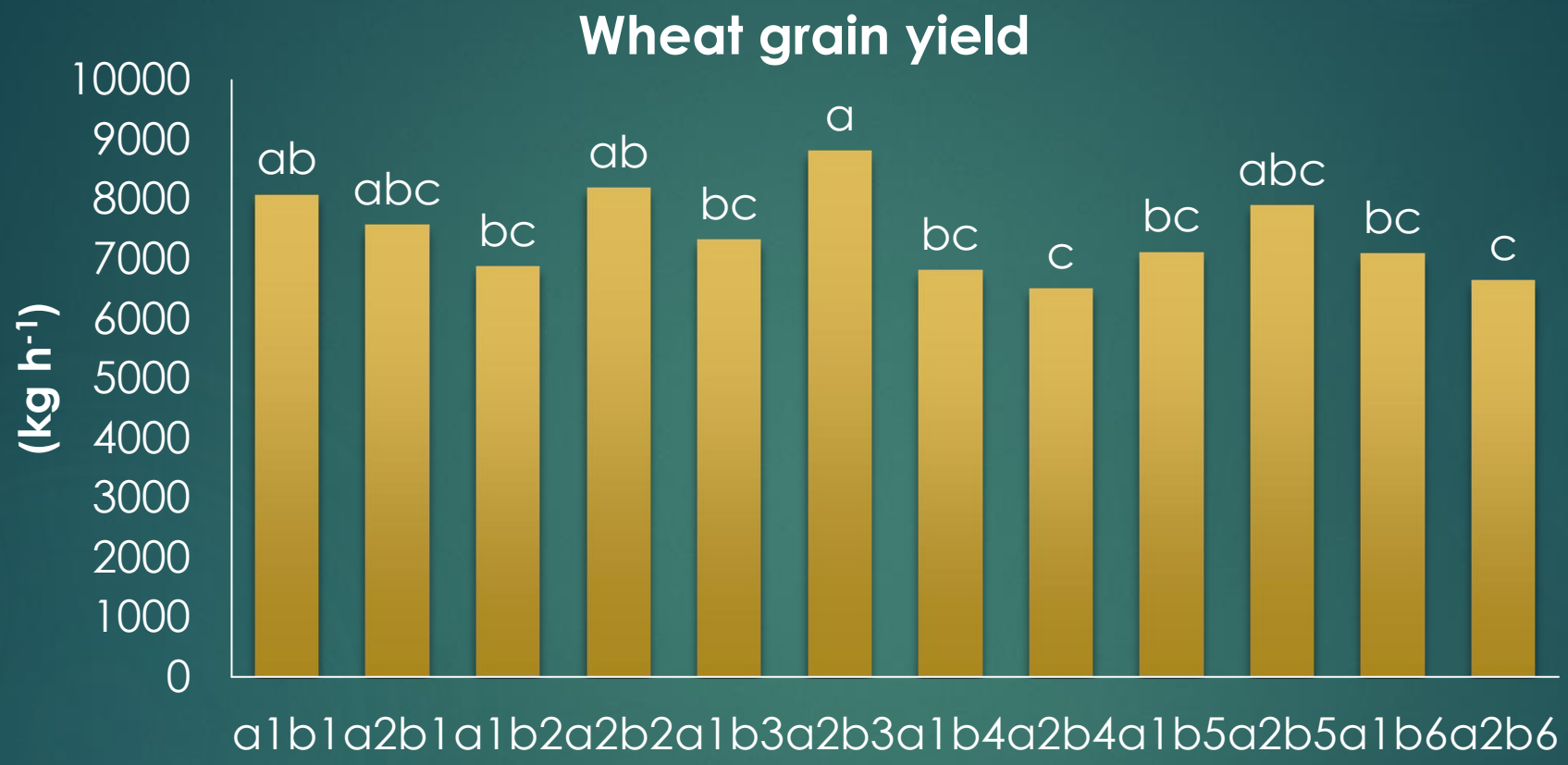
Among the studied crop sequences; the crop sequence of Wheat/Maize-Canola/Maize and also Wheat/Maize-Wheat/Maize were more profitable and economically efficient than other crop sequences. Thus, the referred no-till based crop sequences are recommended for the 1st and 2nd year of this study.

3rd year after effects study

Parsi CV. Irrigated wheat grain yield and yield components Anova in the 3rd year after effects study

Spike weight (g)	Seed no. per meter square	Spike seed number	Plant height (Cm)	Grain yield (Kg h^{-1})	TGW (g)	DF	S.O.V.
0.004^{ns}	4765340^{ns}	0.907^{ns}	37.14^{ns}	82899^{ns}	1.920^{ns}	2	Rep
0.007^{ns}	2722500^{ns}	0.146^{ns}	46.82^{ns}	1341736^{ns}	44.890^{ns}	1	Managed (A)Approach
0.005	3201330	10.673	94.18	109375	7.613	2	E1
0.125**	35694345*	20.071**	200.91**	1786971**	78.095**	5	Crop (B)sequence
0.061*	18332247^{ns}	9.626*	171.74**	1262417**	20.597*	5	AB
0.024	11727587	4.038	22.73	287001	7.743	20	E2
10.1	21.9	10.4	5	7.23	5.9		(CV%)

Mean comparison in the 3rd year after effects study



a1 :Conventional **a2: Conservation**

b1: wheat/Maize-Wheat/Maize
b2: Wheat-Berseem clover/Maize
b3: Wheat/Berseem clover-Canola/Maize
b4: Wheat/Maize-Canola/Maize
b5: Wheat/Maize-Canola/Berseem clover
b6: Wheat/Berseem clover -Wheat/Maize

4th year 1st cropping

4th year -1st cropping in winter

Weed infestation in 4th year 1st cropping in conservation managed approach

5th year 2nd cropping

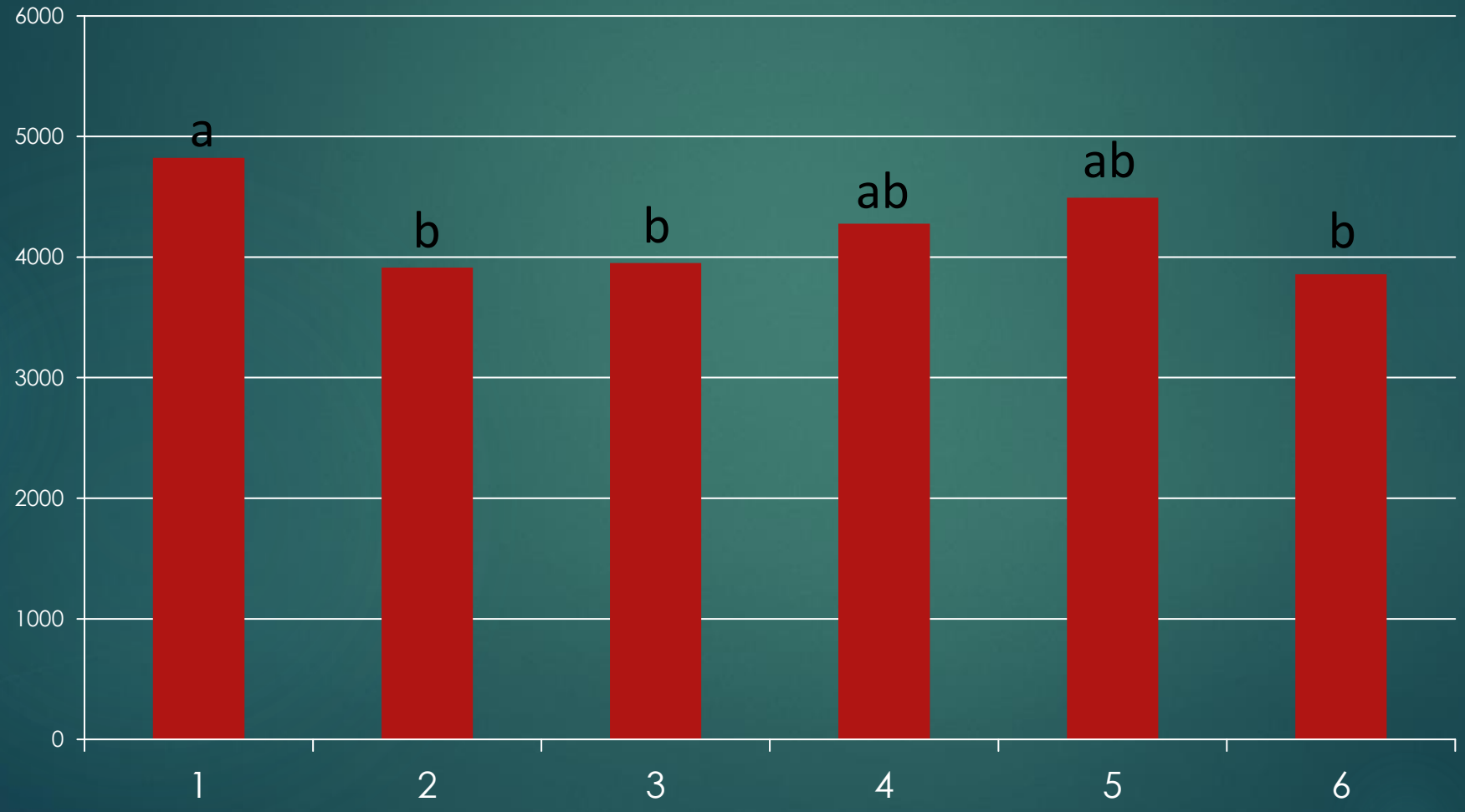
Weed flora of the CA and conventional experiments

Glycyrrhiza glabra
Lolium
Secale cereal
Portulaca oleracea
Centaurea
Abutilon theophrasti
Sorghum halepense
Amaranthus retroflexus
Chrozophora spp.
Cirsium arvense
Convolvulus arvensis
Lepidium spp.
Centaurea spp.
Chenopodium album
Descurainia sophia

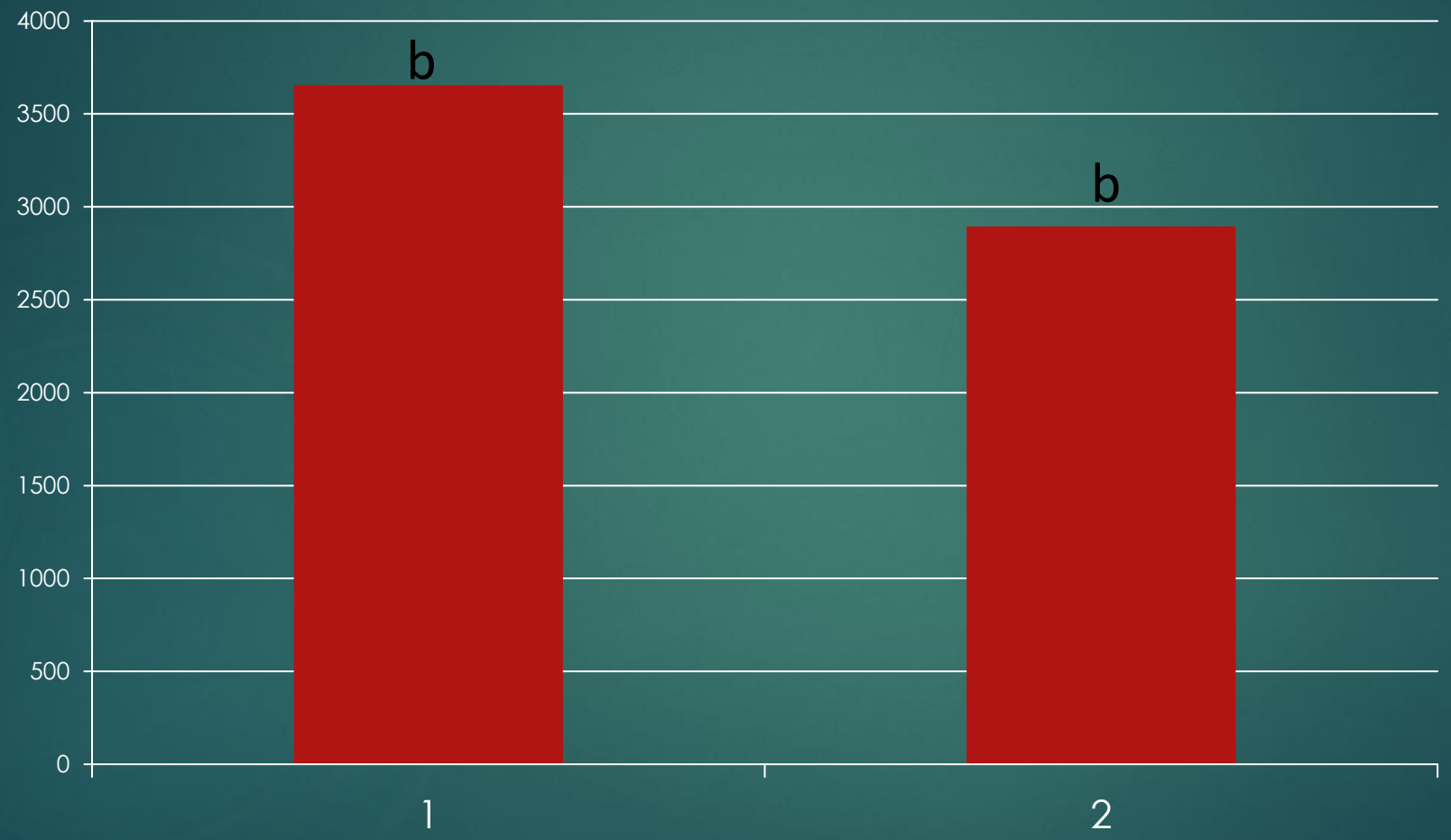
Agylops spp.
Bromus
Hordeum spp.
Galium aparine
wheat grass
Euphorbia
Sainfoin
Cirsium arvense
wild oat
Echium spp.
Papaver Rhoeas

Crop sequence results in 4th and 5th years of study

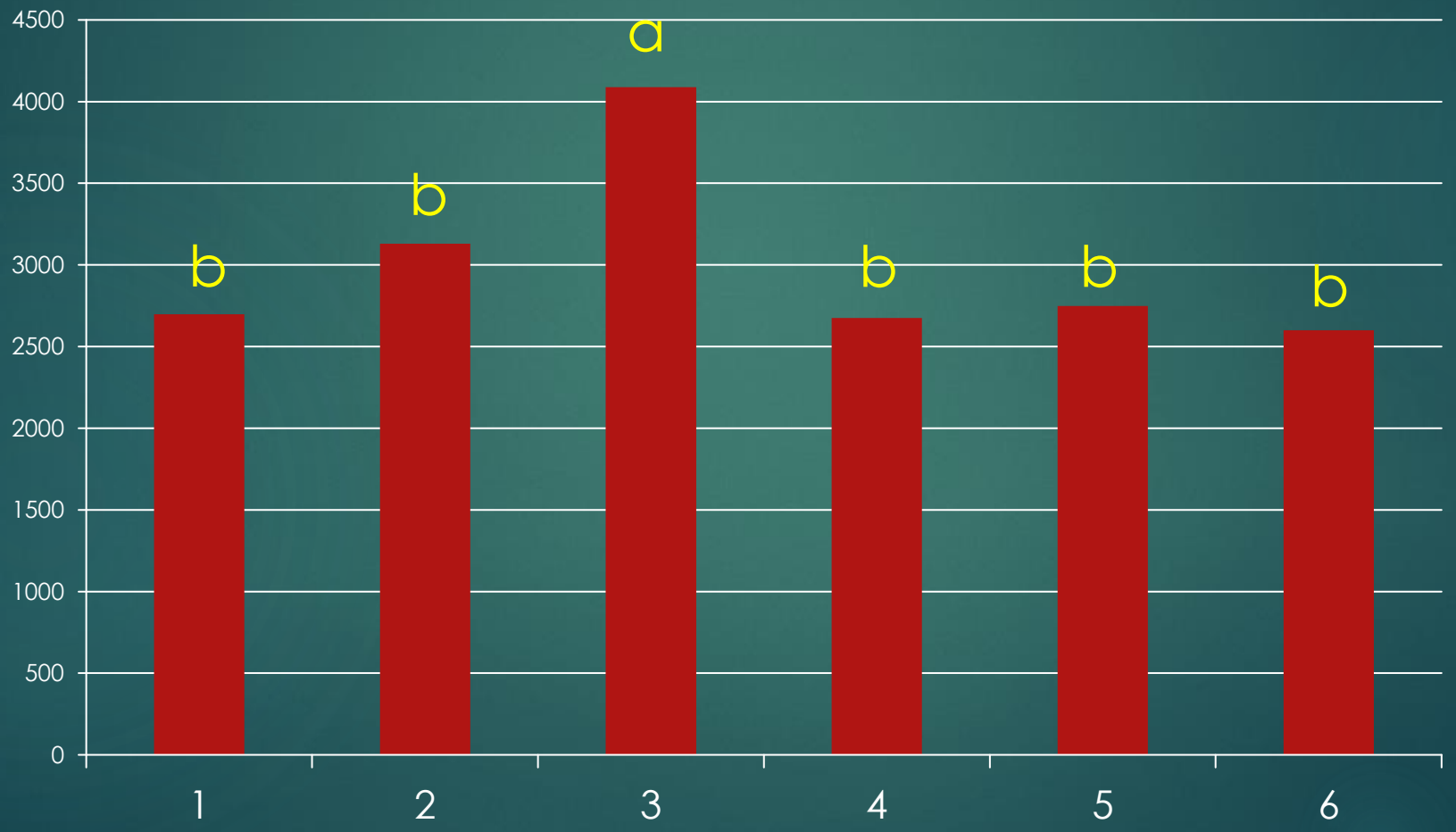
4th year wheat grain yield in conventional approach



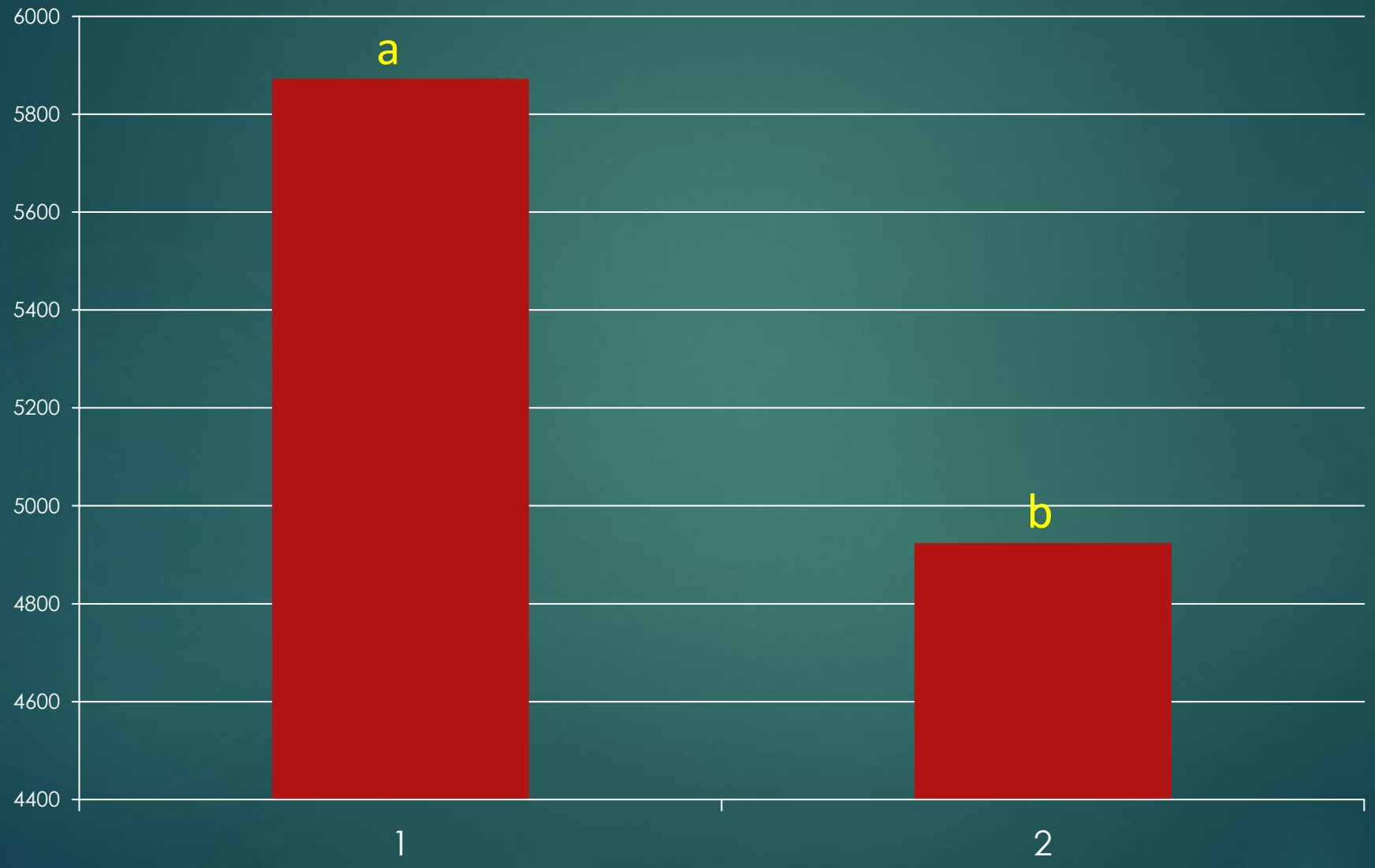
5th year wheat grain yield in conventional approach



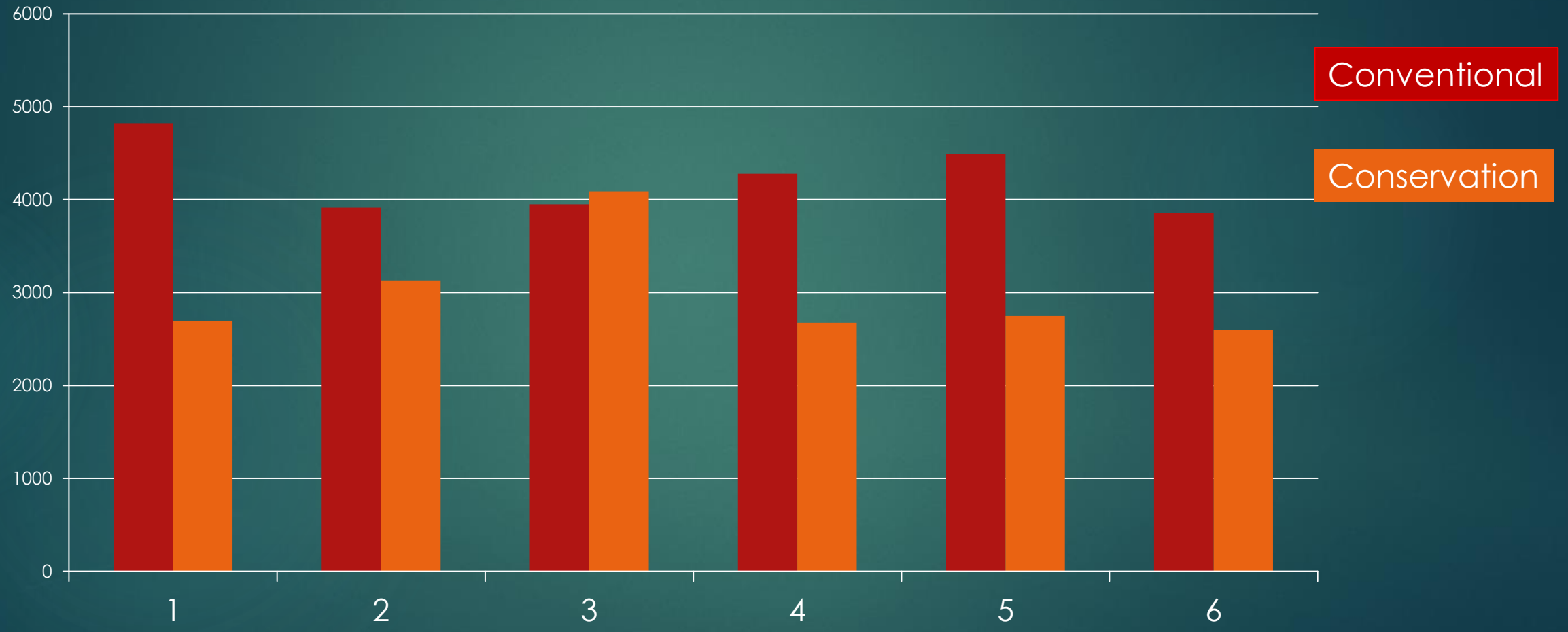
4th year wheat grain yield in conservation approach



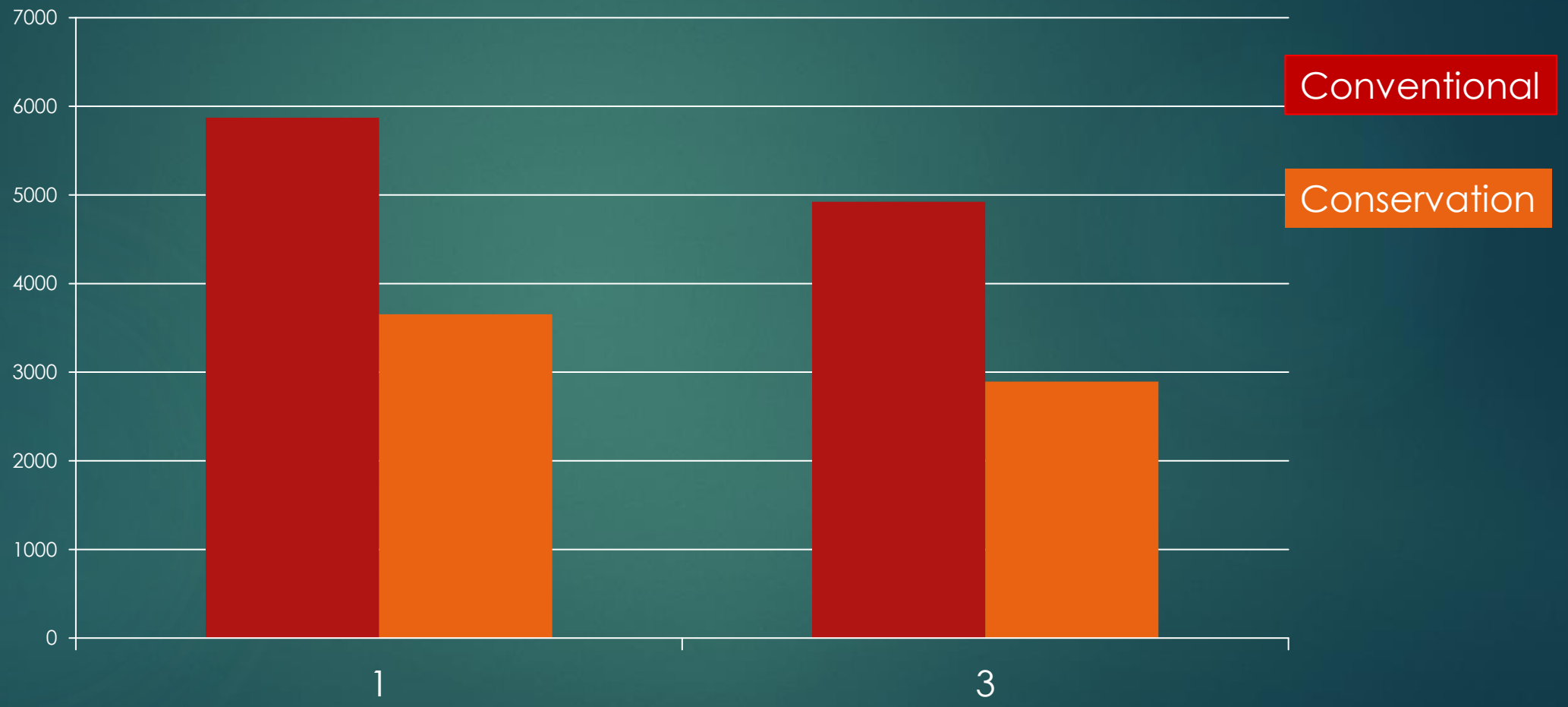
5th year wheat grain yield in conservation approach



4th year wheat grain yield comparison in crop sequences and conventional and conservation approaches



5th year wheat grain yield comparison in crop sequences and conventional and conservation approaches



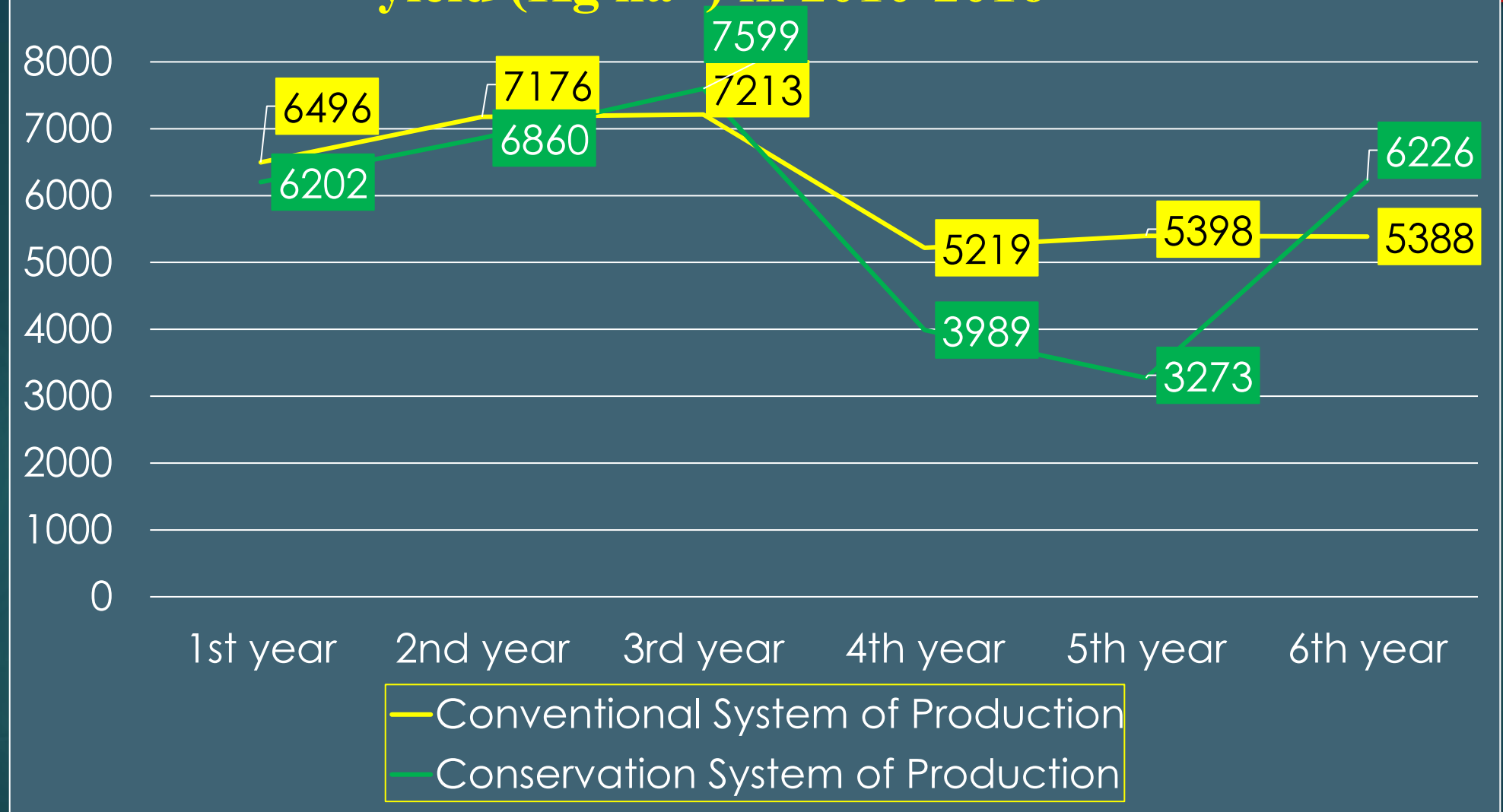
- **The best successful crop sequence for conventional approach is:**

  wheat/maize-wheat/maize

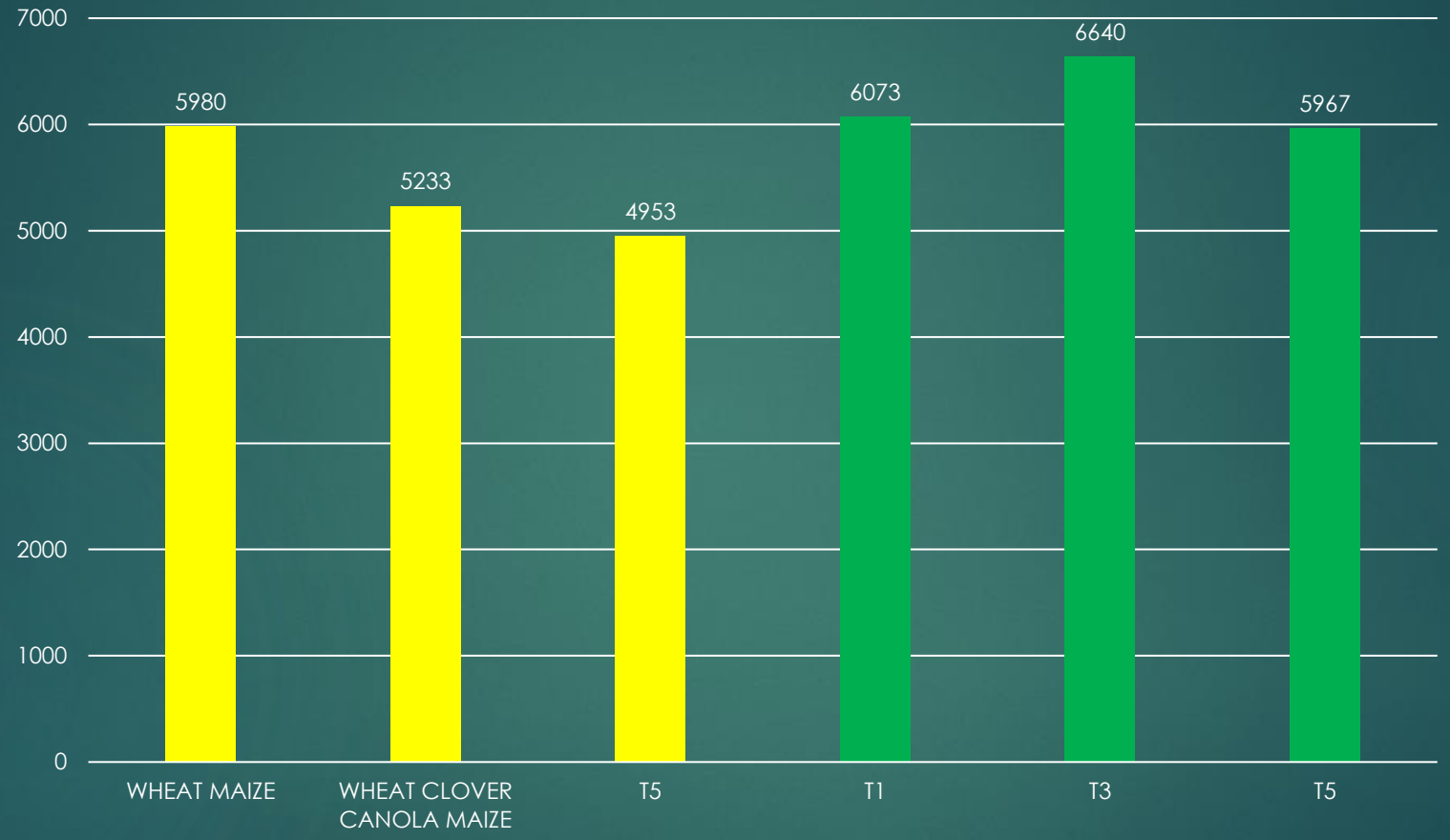
- **The best successful crop sequence for conservation approach is:**

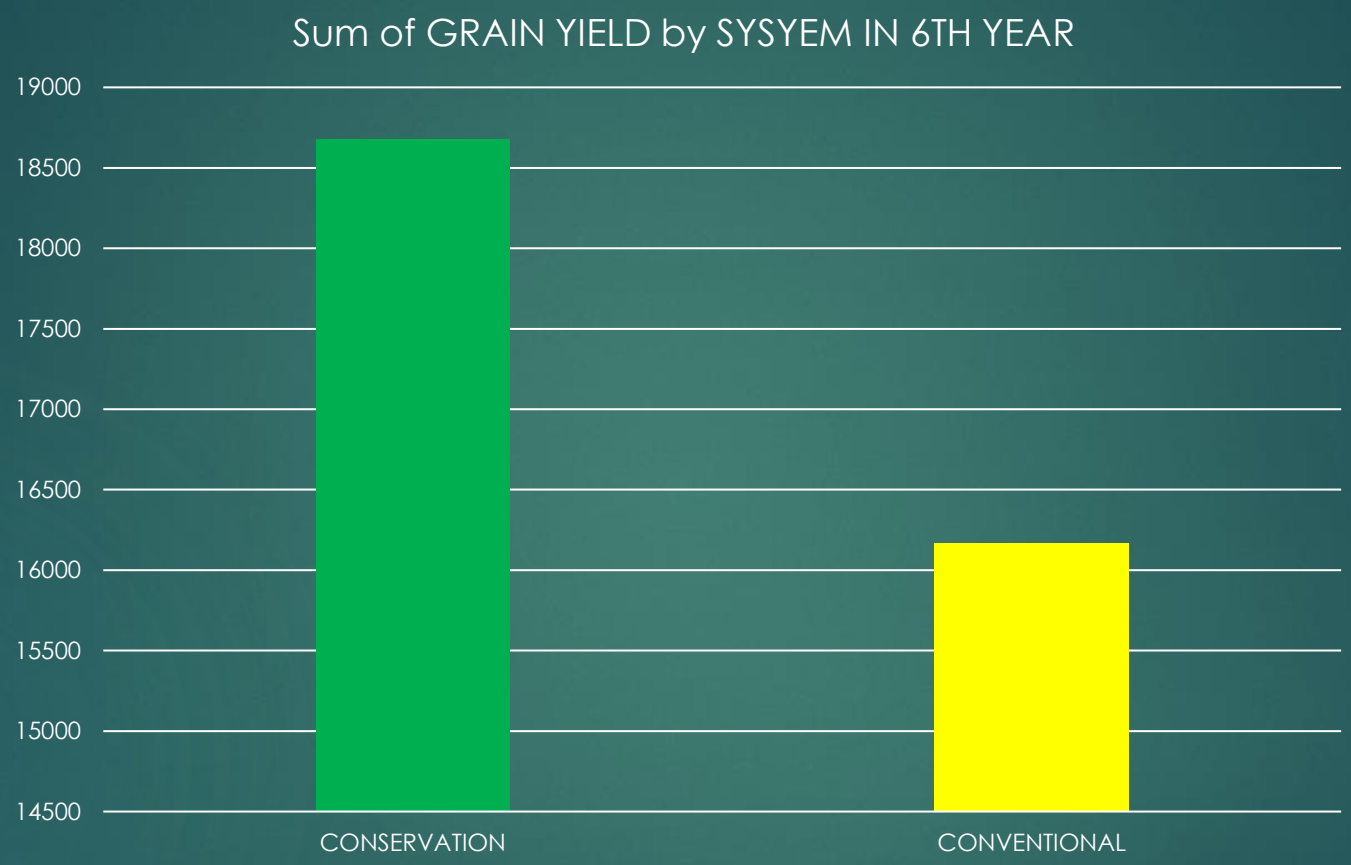
  wheat/berseem-canola/maize

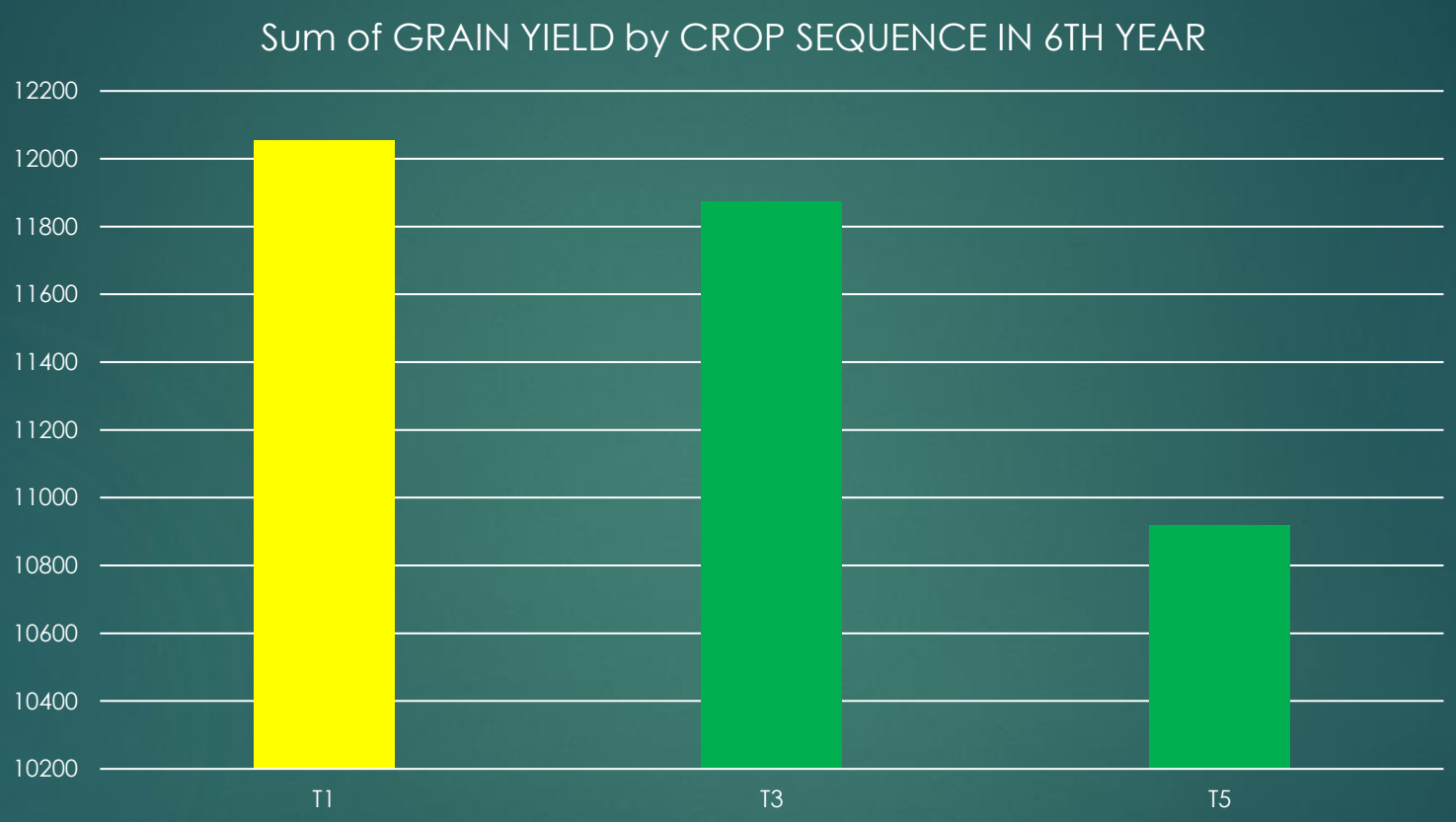
Long term variation in irrigated wheat grain yield (Kg ha^{-1}) in 2010-2016



6TH YEAR IRRIGATED WHEAT GRAIN YIELD AFFECTED BY CONV. AND CONS. BASED SYSTEMS




Sum of GRAIN YIELD by SYSYEM IN 6TH YEAR
19000
18500
18000
17500
17000
16500
16000
15500
15000
14500
CONSERVATION
CONVENTIONAL


Sum of GRAIN YIELD by CROP SEQUENCE IN 6TH YEAR
12200
12000
11800
11600
11400
11200
11000
10800
10600
10400
10200
T1
T3
T5

Total expenses for sprinkler irrigation implementation in Iran: About 1400 US$ per hectare of land

Gross profit: In three management scenarios with grain yield of 3000, 6000 and 10000 kg/ha (38 cents/kg) equals to 986, 1971 and 3286 US dollar, respectively

Thus, we are in shortage of strong coordinated managed approaches to adopt sprinkler irrigation for the small farms in which developing a location specific predefined or standard production system is a necessity

Suggestions

- We are in urgent need of location specific applicable dynamic opportunistic irrigated small grain based cropping systems according to the realities of the production environments in Iran
- So, We need to have a cropping system view instead of one crop view in all aspects related to the crop and soil and its environmental management considering the limitations to have logical demanding from the crop with mutual understanding to provide a local production system coordinated at least in principles but adopted accordingly based on the local environmental realities
- We are in need of activating biological buffers to get the best response from production environment to the managed approaches with the permanent scope of soil health as an inevitable principle

Some irrigated cropping system based managed approaches for successful conservation agriculture implementation in minimum tillage scenario

- The no-till or direct based drills, row crop planters and small seeds seeders are not affordable for a small scale farm, but we need a conventional multi crop seeder with the best overall performance in spring and fall plantings especially in cold irrigated production environmemnts with some specifications of:

a) Precision seed depth

b) Planting unit flexibility to get the best results in furrow irrigated raised bed planting system

c) Preparing a good seedbed with good tilth in one pass with the best soil entry angle to have minimal soil disturbance such as pulverization

d) Good seed to soil contact leaded to a homogenous and speeded germination due to good seedbed configuration and precise planting geometry which is difficult to reach in no-till irrigated cropping system

Some important local problems in No-till Irrigated Cropping System

- **Problems:** Here in no-till we put ourselves in an exaggerated or extreme situation having managerial problems with previous crop residue, weeds with different behaviors, increasing herbicide dependency, uneven irrigation, previous crop seed loss and volunteer plants, soil compaction due to no diversified crop rotation, nutrients stratification, uneven land remained in the fall after harvesting previous crop with heavy weighted vehicles, non-homogenous stand establishment due to non-suitable multi-crop seeder, non-coordinated plant geometry with integrated managements and field access, contradiction between suggested managements and success in continuous cropping system like crop sequence and mouse problem
- **Suggestion:** High cost of sustainable agriculture in no-till format is the most important barrier for irrigated CA based cropping system but integration of double minimum tillage + FIRBPS would be a feasible suggestion for local CA

Main objectives for the future sustainable irrigated cropping systems

- To Provide simple and applicable recommends based on the realities
- To develop agronomic packages specifically for irrigated diversified sequential cropping systems with more than two cropping year cyclically repeated to help to recover the soil health and to upgrade cropping system sustainability
- To Standardize agronomic practices to not to neutralize previous activities based on more resiliency of the system of production
- To continue diversified biomass production as a necessity for soil health in a cropping system viewpoint and in the context of conservation agriculture managed approaches

Long term viability of farming

Crop diversification and its role in upgrading soil organic matter is very much dependent on the agronomic managements as a holistic way of crop production system management. It seems there should be some synergistic effects amongst production system components and dynamism in managerial behaviors is a must for further successful cropping systems. It means the agricultural extension service should always provide different sequential cropping systems as options suggested or recommended to the local farmer to implement in different land divisions separately to lessen the crop production risk.

Probable reasoning for future success

By eliminating moldboard plow and conducting non-inversion surface shallow vertical tillage for bed preparation only through disk harrow, we let the soil to defend its stable condition, good tilth, balanced aeration through the crop sequence cycles which should be regarded as necessities for any further successful cropping systems.

Land levelling essential for successful irrigated CA

Land levelling is a necessity for keeping homogeneity of soil fertility and moisture distribution across the field in the long term continuous management especially in irrigated lands. Because, I think the 1st principle of succeeding in conservation agriculture under the conditions of minimum tillage, furrow irrigation and diversified crop sequence as a pre-defined holistic cropping system is the homogeneity of biomass distribution as residue on the soil surface or buried in shallow depth of the soil.

Through the tillage done on O horizon and A horizon, the buried residue from different sources or crops are better in access of the food web especially worms without no more energy consumption by worms for residue transfer from the soil surface thus making remaining more body mass for further SOM upgrading. In fact, in this condition the horizon b would be biologically tilled by crops like berseem clover and canola.

Shallow tillage as a suitable mechanical seedbed preparation has a key role for producing more biomass by different crops in the crop sequence helping soil to get fertile better and faster and nourishing next crops in the sequence more longer and better than before.

In the suggested cropping systems, the seedbed geometry and planting configurations are not separately seen. Because, in any managed system approach they are interconnected from the beginning till the end of the cropping system cycle and should be holistically studied.

Successful establishment for any crops in the sequence should be regarded as the 1st priority. Because the production system sustainability is completely dependent on it.

- In double or triple no-till or minimum till systems we can't conduct a successful seeding without any seedbed soil preparatory tillage especially after harvesting silage maize in the fall in a rotted land, with low temperature and high in moisture content.

Weed management in the context of CA with more important specifications like minimum tillage, furrow irrigation and diversified cropping systems include at least three managements of agronomic (crop sequence), mechanical (field access to mechanically controlling weeds while using band placement of fertilizers and chemical. The chemical weed management includes two scenarios: the 1st scenario involves general off season weed management in turnaround time through application of general herbicides and the 2nd scenario of specific weed management through application of specific herbicides. It should be reminded that in this weed management system we do not use any GM crop and also we have volunteer wheat or barley seeds germinated in the next summer crop land or even in the next fall season crops like maize and canola.

Here we are seeking to provide a complete applicable agronomic package based on the realities including accessions and limitations for the farmers of the Alborz province and at Karaj with climatic specifications of arid region according to De Martonne aridity index (1926), with the annual mean temperature of 15.1° Celsius, the annual precipitation of about 250mm, the Kc of 10.0 and the annual mean evaporation of 2184mm. The farmers of this region are not to provide water for their crops through using pressurized irrigation systems especially due to its economic and feasibility considerations. They have dominantly used the furrow irrigation system through the decades in the context of conventional tillage and are seeking to make it much more economic or sustainable via using applicable managed approaches.

There are some challenges implementing no-till in the mentioned climate with the consideration of all the limitations and managerial options. The 1st problem is soil compaction especially in the fall that causes heterogeneity in crop establishment due to the reasons like planting seeds in a cold soil, high in moisture and with surface residue. This compaction is an obligation because of machinery trafficking and their tires for silage maize biomass harvesting and collecting causing uneven furrows with the depth of almost to 30cm in the soil which needs to be repaired by further land preparations. So, this harvesting obligation is not avoidable especially from the point of the silage maize seller. In fact, the seller is willing to sell his product with the highest moisture content meaning that he should preserve silage moisture via irrigating very nearly to the harvesting time. In this condition, we can't implement double no-till through whole crop season and are just confined to implement single no-till just in early summer after harvesting wheat or barley and through keeping their residue and then planting maize seeds. Thus, here we do not have permanent soil cover as a CA principle in a no-till system.

The moderation principle is an applicable principle here I suggest for the next near future successful feasible cropping systems in irrigated lands of Iran. In fact, we should consider the functional relationships of the production systems components in integrated crop managements interconnected manners especially in the irrigated CA based cropping systems. This means that for instance if we are going to till the soil in a logical behavior less than conventional tillage as an extreme behavior, we should regard its components as:

a. Soil compaction and its impact on soil oxygen besides of its moisture and balancing these two components

b. Seedbed preparation suitability

c. Fertilizer management

d. Irrigation system and management

e. Agricultural machinery in-season field access

f. Integrated weed management.

We here don’t recommend basin irrigation by making ridges for the divided irrigation long strips. Because a large proportion of the land is lost from the production cycle. We think making furrows following shallow disk harrow and land levelling is the best recommendation for the farmers because of its numerous advantages such as: making best raised beds especially bed tops providing needed fertile soil for the crop through making furrows as the best bed geometry.

Maybe we should substitute the term of “permanent soil cover by residue” in CA with making stable soil through using diversified cropping system, suitable crop sequence, elimination of moldboard plow, shallow or limited soil tillage without reversing soil, good seedbed preparation considering its geometry and relationship with seeding configuration of any of the crops in sequence. Because by doing CA we are going to Provide and maintain an optimum environment of the root-zone to maximum possible depth (Here suggested as suitable depth due to limiting water percolation, minimizing nutrient loss, etc.). Probably, merging O and A horizons in the course of shallow tillage can be a good approach in distributing the concentrated fertilizers in the O horizon in no-till system such as phosphorus stratification and its consequences. Favoring beneficial biological activity in the soil to: a. Maintain and rebuild soil architecture b. Compete with potential in-soil pathogens c. Contribute to soil organic matter and various grades of humus D. contribute to capture, retention, chelation and slow release of plant nutrients and also avoiding any physical or chemical damage to the roots that disrupts their effective functioning. In fact, if CA is based on enhancing natural biological processes above and below the ground, we have to activate biological processes more than what it is in conventional tillage by moderate behavior of balancing soil oxygen and moisture percentages.

CA Challenges no-till format

- Soil compaction especially in wheat-corn double cropping system
- No solution for the fall no-till implantation in moist cold soil
- Fall Late harvest of silage maize thus late irrigated wheat sowing in moist cold compact non-levelled bad seedbed with less future grain yield, biomass and residue due to late germination and less competitiveness of host plant with weeds
- Weed infestation from 3rd year onwards
- Non-homogenous irrigation across the field because of border irrigation instead of furrow irrigation
- No multi purpose seeder compatible with small scale fields (less than 5 hectares) and specialized for sowing all the seeds of crops in rotation in irrigated lands

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TARASHKADEH

1st year wheat into wheat residue in no-till
border irrigated cropping system

1st year wheat into wheat residue in no-till
border irrigated cropping system

1st year wheat into burned previous wheat residue in conventional furrow irrigated raised bed planting system

1st year wheat into burned previous wheat residue in conventional furrow irrigated raised bed planting system

1st year wheat into burned previous wheat
residue in conventional furrow irrigated
.raised bed planting system

1st year wheat into burned previous wheat
residue in conventional furrow irrigated
.raised bed planting system

1st year wheat into wheat residue in no-till
border irrigated cropping system

1st year wheat into wheat residue in no-till
border irrigated cropping system

1st year wheat into wheat residue in no-till
border irrigated cropping system

سازمان هواشناسی کشور
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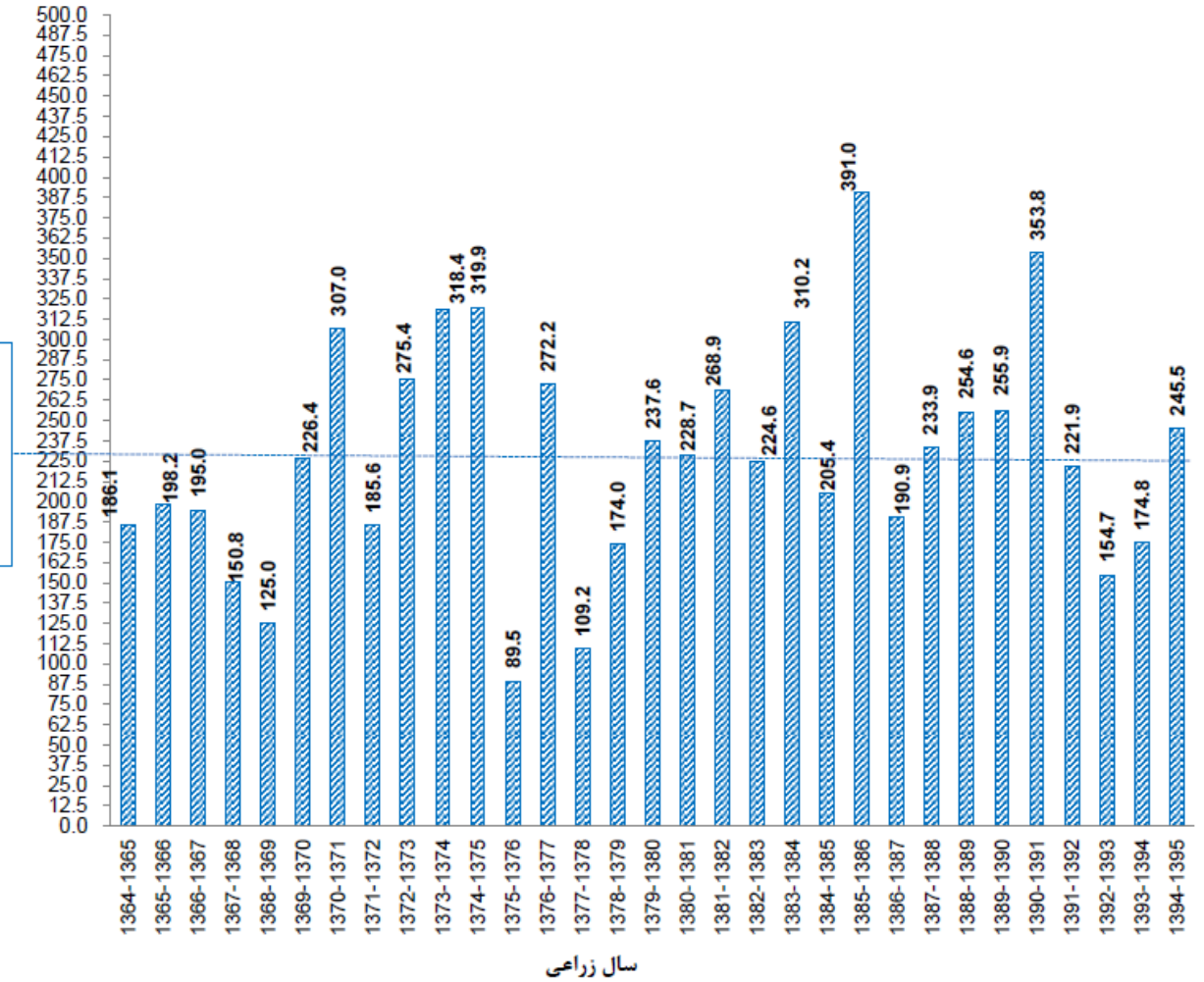
ادارہ کل هواشناسی استان البرز

مجموع بارندگی در هر سال زراعی تا ۸ تیر ماه در ایستگاه کرج



مجموع بارندگی تا ۸ تیر ماه در هرسال زراعی در ایستگاه کرج	
میزان بارش	سال زراعی
۱۸۶.۱	۱۳۶۴-۱۳۶۵
۱۹۸.۲	۱۳۶۵-۱۳۶۶
۱۹۵.۰	۱۳۶۶-۱۳۶۷
۱۵۰.۸	۱۳۶۷-۱۳۶۸
۱۲۵.۰	۱۳۶۸-۱۳۶۹
۲۲۶.۴	۱۳۶۹-۱۳۷۰
۳۰۷.۰	۱۳۷۰-۱۳۷۱
۱۸۵.۶	۱۳۷۱-۱۳۷۲
۲۷۵.۴	۱۳۷۲-۱۳۷۳
۳۱۸.۴	۱۳۷۳-۱۳۷۴
۳۱۹.۹	۱۳۷۴-۱۳۷۵
۸۹.۵	۱۳۷۵-۱۳۷۶
۲۷۲.۲	۱۳۷۶-۱۳۷۷
۱۰۹.۲	۱۳۷۷-۱۳۷۸
۱۷۴.۰	۱۳۷۸-۱۳۷۹
۲۳۷.۶	۱۳۷۹-۱۳۸۰
۲۲۸.۷	۱۳۸۰-۱۳۸۱
۲۶۸.۹	۱۳۸۱-۱۳۸۲
۲۲۴.۶	۱۳۸۲-۱۳۸۳
۳۱۰.۲	۱۳۸۳-۱۳۸۴
۲۰۵.۴	۱۳۸۴-۱۳۸۵
۳۹۱.۰	۱۳۸۵-۱۳۸۶
۱۹۰.۹	۱۳۸۶-۱۳۸۷
۲۳۳.۹	۱۳۸۷-۱۳۸۸
۲۵۴.۶	۱۳۸۸-۱۳۸۹
۲۵۵.۹	۱۳۸۹-۱۳۹۰
۳۵۳.۸	۱۳۹۰-۱۳۹۱
۲۲۱.۹	۱۳۹۱-۱۳۹۲
۱۵۴.۷	۱۳۹۲-۱۳۹۳
۱۷۴.۸	۱۳۹۳-۱۳۹۴
۲۴۵.۵	۱۳۹۴-۱۳۹۵

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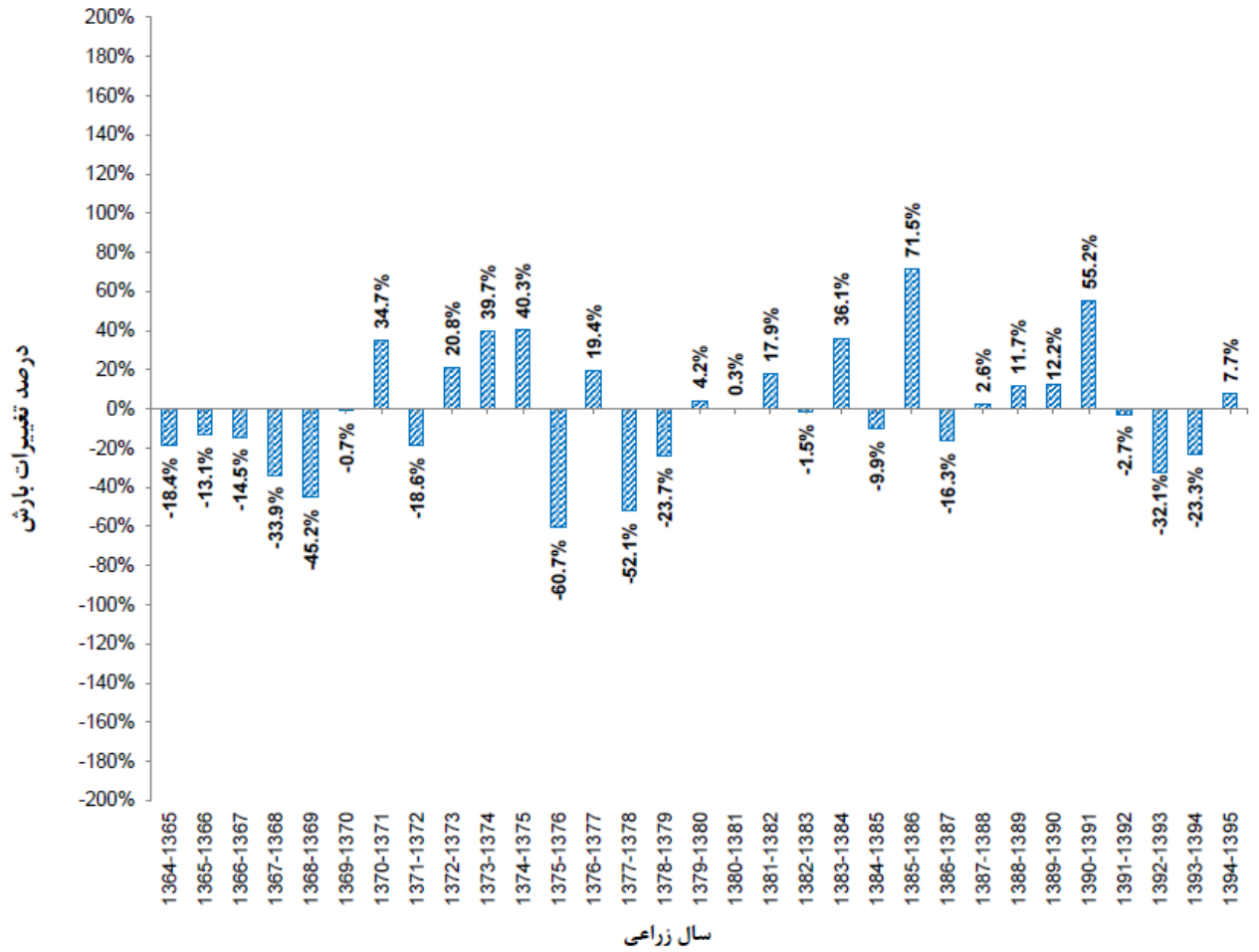
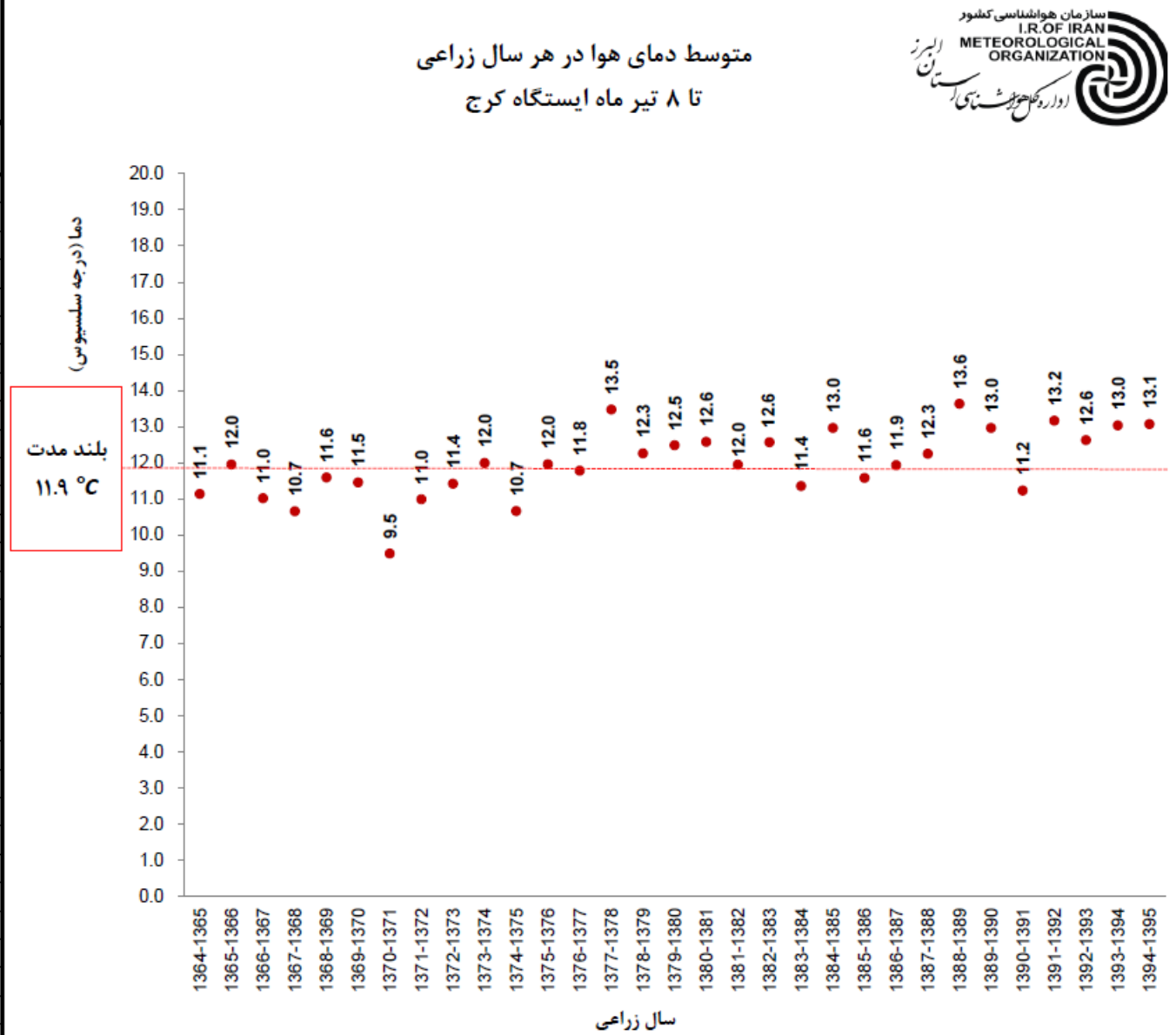
درصد تغییرات بارش نسبت به میانگین در هر سال زراعی تا ۸ تیر ماه در ایستگاه کرج



درصد تغییرات بارش نسبت به میانگین تا ۸ تیر ماه در هر سال زراعی ایستگاه کرج	
درصد تغییرات	سال زراعی
-۱۸.۴٪	۱۳۶۴-۱۳۶۵
-۱۳.۱٪	۱۳۶۵-۱۳۶۶
-۱۴.۵٪	۱۳۶۶-۱۳۶۷
-۳۳.۹٪	۱۳۶۷-۱۳۶۸
-۴۵.۲٪	۱۳۶۸-۱۳۶۹
-۰.۷٪	۱۳۶۹-۱۳۷۰
۳۴.۷٪	۱۳۷۰-۱۳۷۱
-۱۸.۶٪	۱۳۷۱-۱۳۷۲
۲۰.۸٪	۱۳۷۲-۱۳۷۳
۳۹.۷٪	۱۳۷۳-۱۳۷۴
۴۰.۳٪	۱۳۷۴-۱۳۷۵
-۶۰.۷٪	۱۳۷۵-۱۳۷۶
۱۹.۴٪	۱۳۷۶-۱۳۷۷
-۵۲.۱٪	۱۳۷۷-۱۳۷۸
-۲۳.۷٪	۱۳۷۸-۱۳۷۹
۴.۲٪	۱۳۷۹-۱۳۸۰
۰.۳٪	۱۳۸۰-۱۳۸۱
۱۷.۹٪	۱۳۸۱-۱۳۸۲
-۱.۵٪	۱۳۸۲-۱۳۸۳
۳۶.۱٪	۱۳۸۳-۱۳۸۴
-۹.۹٪	۱۳۸۴-۱۳۸۵
۷۱.۵٪	۱۳۸۵-۱۳۸۶
-۱۶.۳٪	۱۳۸۶-۱۳۸۷
۲.۶٪	۱۳۸۷-۱۳۸۸
۱۱.۷٪	۱۳۸۸-۱۳۸۹
۱۲.۲٪	۱۳۸۹-۱۳۹۰
۵۵.۲٪	۱۳۹۰-۱۳۹۱
-۲.۷٪	۱۳۹۱-۱۳۹۲
-۳۲.۱٪	۱۳۹۲-۱۳۹۳
-۲۳.۳٪	۱۳۹۳-۱۳۹۴
۷.۷٪	۱۳۹۴-۱۳۹۵

متوسط دمای هوا در هر سال زراعی تا ۸ تیر ماه در هر سال زراعی در ایستگاه کرج	
دما (درجه سلسیوس)	سال زراعی
۱۱.۱	۱۳۶۴-۱۳۶۵
۱۲.۰	۱۳۶۵-۱۳۶۶
۱۱.۰	۱۳۶۶-۱۳۶۷
۱۰.۷	۱۳۶۷-۱۳۶۸
۱۱.۶	۱۳۶۸-۱۳۶۹
۱۱.۵	۱۳۶۹-۱۳۷۰
۹.۵	۱۳۷۰-۱۳۷۱
۱۱.۰	۱۳۷۱-۱۳۷۲
۱۱.۴	۱۳۷۲-۱۳۷۳
۱۲.۰	۱۳۷۳-۱۳۷۴
۱۰.۷	۱۳۷۴-۱۳۷۵
۱۲.۰	۱۳۷۵-۱۳۷۶
۱۱.۸	۱۳۷۶-۱۳۷۷
۱۳.۵	۱۳۷۷-۱۳۷۸
۱۲.۳	۱۳۷۸-۱۳۷۹
۱۲.۵	۱۳۷۹-۱۳۸۰
۱۲.۶	۱۳۸۰-۱۳۸۱
۱۲.۰	۱۳۸۱-۱۳۸۲
۱۲.۶	۱۳۸۲-۱۳۸۳
۱۱.۴	۱۳۸۳-۱۳۸۴
۱۳.۰	۱۳۸۴-۱۳۸۵
۱۱.۶	۱۳۸۵-۱۳۸۶
۱۱.۹	۱۳۸۶-۱۳۸۷
۱۲.۳	۱۳۸۷-۱۳۸۸
۱۳.۶	۱۳۸۸-۱۳۸۹
۱۳.۰	۱۳۸۹-۱۳۹۰
۱۱.۲	۱۳۹۰-۱۳۹۱
۱۳.۲	۱۳۹۱-۱۳۹۲
۱۲.۶	۱۳۹۲-۱۳۹۳
۱۳.۰	۱۳۹۳-۱۳۹۴
۱۳.۱	۱۳۹۴-۱۳۹۵



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درصد تغییرات دمای هوا نسبت به میانگین تا ۸ تیر ماه در هر سال زراعی ایستگاه کرج	
درصد تغییرات	سال زراعی
-۶.۷٪	۱۳۶۴-۱۳۶۵
۰.۱٪	۱۳۶۵-۱۳۶۶
-۷.۷٪	۱۳۶۶-۱۳۶۷
-۱۰.۷٪	۱۳۶۷-۱۳۶۸
-۲.۹٪	۱۳۶۸-۱۳۶۹
-۴.۰٪	۱۳۶۹-۱۳۷۰
-۲۰.۵٪	۱۳۷۰-۱۳۷۱
-۸.۰٪	۱۳۷۱-۱۳۷۲
-۴.۳٪	۱۳۷۲-۱۳۷۳
۰.۵٪	۱۳۷۳-۱۳۷۴
-۱۰.۷٪	۱۳۷۴-۱۳۷۵
۰.۲٪	۱۳۷۵-۱۳۷۶
-۱.۳٪	۱۳۷۶-۱۳۷۷
۱۲.۸٪	۱۳۷۷-۱۳۷۸
۲.۷٪	۱۳۷۸-۱۳۷۹
۴.۶٪	۱۳۷۹-۱۳۸۰
۵.۴٪	۱۳۸۰-۱۳۸۱
۰.۱٪	۱۳۸۱-۱۳۸۲
۵.۳٪	۱۳۸۲-۱۳۸۳
-۴.۹٪	۱۳۸۳-۱۳۸۴
۸.۶٪	۱۳۸۴-۱۳۸۵
-۳.۰٪	۱۳۸۵-۱۳۸۶
۰.۰٪	۱۳۸۶-۱۳۸۷
۲.۶٪	۱۳۸۷-۱۳۸۸
۱۴.۲٪	۱۳۸۸-۱۳۸۹
۸.۶٪	۱۳۸۹-۱۳۹۰
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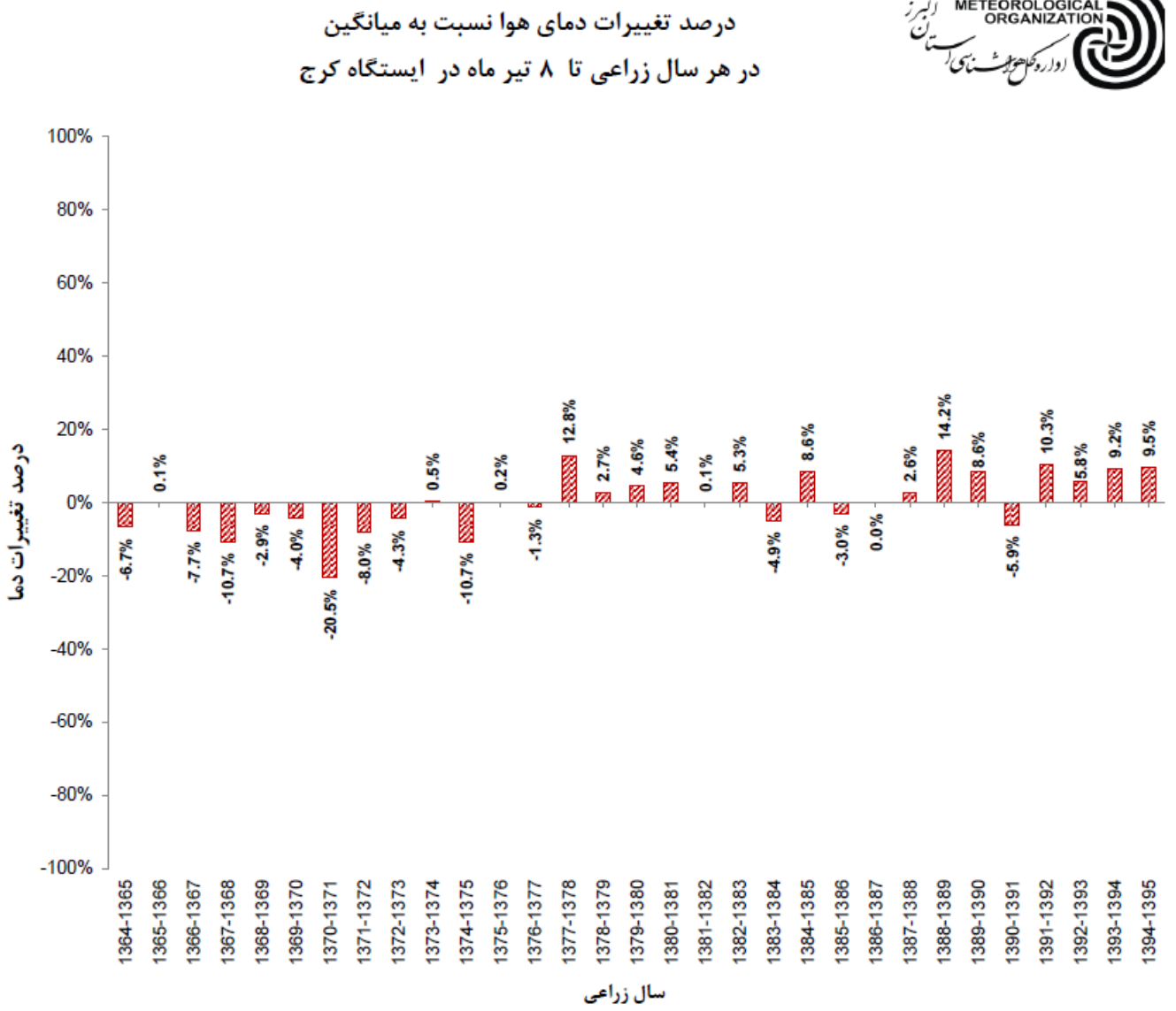
۱۰.۳٪	۱۳۹۱-۱۳۹۲
۵.۸٪	۱۳۹۲-۱۳۹۳
۹.۲٪	۱۳۹۳-۱۳۹۴
۹.۵٪	۱۳۹۴-۱۳۹۵



Pressurized irrigation systems limitations (technical, social, economic and natural)

- High expenses (primary, repair and maintenance)
- No standards for irrigate field crops production systems
- Wind velocity and frequency
- Soil texture (much runoff in compact and clay soils)
- High energy consumption especially in sprinkler irrigation systems
- Intrinsic limitations of the irrigation system lowering productivity
- Installation problems and limitations
- Unknown yield difference between the old and new system

No-till challenges in irrigated environments

- Ruts and gullies created by truck in fall obligating land levelling
- Mice increasing population
- Moist not well drained cold soil in fall increased by no-till with late and risky planting
- Weed yearly increasing infestation
- Herbicide increasing dependency
- Soil compaction provided that we have a diversified adoptable crop sequence
- Nutrients accumulation top soil layer and stratification
- Phosphorus runoff
- We don not have heavy rains
- Expensive high pressure irrigation system not preferred by farmers

Some details

Limited disking, harrowing or harrow–air–planters are used in reduced tillage operations to bury surface crop debris, kill emerging weeds, and incorporate seed and/or fertilizer. Proper chopping and spreading of straw and chaff during harvest of the previous crop is important for successful sowing and is critical for no-till operations.

Diversified crop sequence

- Diversified crop sequence is a system of diversity in time with many agronomic, dynamic and economic advantages
- The worst crop sequence for CA is wheat/maize double cropping with many disadvantages such as: soil compaction, weed infestation increasing pressure, decreasing quantity and quality of the crops and not sustainable cropping system. but good for the conventional system of production with just economic benefits

Some necessities for an operational CA through implementing minimum tillage plus raised bed planting system in irrigated lands

- Increasing areas of soil degradation through phenomenon of erosion, accumulation of salts and salinization in countries
- Increasing destruction of fertile soil layer rich in humus through consistent implementation intensive agriculture
- Increasing soil carbon dioxide emission and decreasing cropping systems biodiversity due to continuous outflow of crop residue from the soil

Plant diversity and root traits benefit physical properties key to soil function in grasslands

- Plant diversity loss impairs ecosystem functioning, including important effects on soil. Most studies that have explored plant diversity effects belowground, however, have largely focused on biological processes. As such, our understanding of how plant diversity impacts the soil physical environment remains limited, despite the fundamental role soil physical structure plays in ensuring soil function and ecosystem service provision. Here, in both a glasshouse and a long-term field study, we show that high plant diversity in grassland systems increases soil aggregate stability, a vital structural property of soil, and that root traits play a major role in determining diversity
- effects. We also reveal that the presence of particular plant species within mixed communities affects an even wider range of soil physical processes, including hydrology and soil strength regimes. Our results indicate that alongside well-documented effects on ecosystem functioning, plant diversity and root traits also benefit essential soil physical properties.
- Ref: Ecology Letters, (2016) 19: 1140–1149